SECTION 1

INSPECTION, TEST PIT EXPLORATION AND DYE TEST REPORT FRANKLIN FALLS DAM FRANKLIN, NEW HAMPSHIRE

CONTRACT DACW-33-85-D-0011
CONTRACTING OFFICER:
Edward D. Hammond, LTC, CE

DELIVERY ORDER NO. 0012
24 June 1986

PREPARED FOR: U. S. Army Corps of Engineers
New England Division
424 Trapelo Road
Waltham, MA 02254-9149

PREPARED BY: Atlantic Testing Laboratories, Limited
P.O. Box 29
Canton, New York 13617

September 19, 1986

ATL Report No. CD015-1-7-86

SECTION 2

SECTION 2

TABLE OF CONTENTS

SECTION 3

SCOPE OF INVESTIGATION

a. Delivery Order No. 0012

CHECKED BOX APPLIES: [X] ORDER FOR SUPPLIES OR SERVI(

RETURN COPIES OF THIS QUOTE BY (THIS IS NOT AN ORDER. See DD Form 1155r)

1

1 CONTRACT NO.	2. DELIVERY ORDER NO.	3. DATE OF ORDER	4. REQUISITION PURCH REQUEST NO	5. CERTIFIED FOR NATIONAL DEFENSE UNDER DMS REG 1
DACW33-85-D-0011	0012	86 JUN 24	GEB 86-60	DO

6. ISSUED BY: Dept. of the Army — CODE
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, MA 02254-9149
Buyer/Symbol: Hebert/NEDSD-P Phone: AC 617-647-8207

7. ADMINISTERED BY (If other than 6) — CODE

8. DELIVERY FOB: [X] DEST [ ] OTHER (See Schedule if other)

9. CONTRACTOR/QUOTER — CODE — FACILITY CODE

NAME AND ADDRESS
Atlantic Testing Laboratories, LTD
P.O. Box 29
Canton, NY 13617

10. DELIVER TO FOB POINT BY: In accordance with Paragraph 7 of the Attachment

11. CHECK IF BUSINESS IS: [X] SMALL [ ] SMALL DISADVANTAGED [ ] WOMEN-OWNED

12. DISCOUNT TERMS: NET

13. MAIL INVOICES TO: Finance & Accounting Officer at Issuing Office

14. Services for: — CODE
U. S. Army Engineer Division, New England
ATTN: Geotechnical Engineering Branch
424 Trapelo Road
Waltham, MA 02254-9149

15. PAYMENT WILL BE MADE BY: — CODE
Finance & Accounting Officer at Issuing Office

MARK ALL PACKAGES AND PAPERS WITH CONTRACT OR ORDER NUMBER

16. TYPE OF ORDER
DELIVERY [X]
PURCHASE [ ]

This delivery order is subject to instructions contained on this side of form only and is issued on another Government agency or in accordance with and subject to terms and conditions of above numbered contract.

Reference your furnish the following on terms specified herein, including, for U.S. purchases.

General Provisions of Purchase Order on DD Form 1155r (EXCEPT CLAUSE NO. 12 APPLIES ONLY IF THIS BOX [ ] IS CHECKED, AND NO. 14 IF THIS BOX [ ] IS CHECKED); special provisions ; and delivery as indicated. This purchase is negotiated under authority of 10 USC 2304(a)(3) or as specified in the schedule if within the U.S., its possessions or Puerto Rico; if otherwise under 2304(a)(6).

[ ] Checked, Additional General Provisions apply; Supplier shall sign "Acceptance" on DD Form 1155r and return copies.

17. ACCOUNTING AND APPROPRIATION DATA/LOCAL USE
96X3123 O & M CE Civil
C 109074000A000 (MC)
Contract

Camallondo 6/24/86

SBSA Status GEB
AE/PS Coord SO
JJH/ln

18. ITEM NO.	19. SCHEDULE OF SUPPLIES/SERVICES	20. QUANTITY ORDERED/ ACCEPTED *	21. UNIT	22. UNIT PRICE	23. AMOUNT
	Furnish necessary Services and Equipment for Exploration and Dye Testing of Soils at Franklin Falls Dam, New Hampshire, in accordance with instructions contained in Attachment No. 1.	APPROX.			ESTIMATED
1.1	Geologist	40	hr	$ 40.00	$ 1,600.00
.3	Per Diem — Overnight Stay	5	day	45.00	225.00
1.4	Mileage from Waltham, MA & Return	200	hr/mi	0.35	70.00
.0	Geotechnical Service and Report	1	job	60% of 1.1	960.00

* If quantity accepted by the Government is same as quantity ordered, indicate by √ mark. If different, enter actual quantity accepted below quantity ordered and encircle.

24. UNITED STATES OF AMERICA
BY: EDWARD D. HAMMOND, LTC, CE
Deputy Division Engineer
CONTRACTING OFFICER

25. TOTAL: $ 2,855.00

29. DIFFERENCES

26. QUANTITY IN COLUMN 20 HAS BEEN:
[ ] INSPECTED [ ] RECEIVED [ ] ACCEPTED, AND CONFORMS TO THE CONTRACT EXCEPT AS NOTED

DATE — SIGNATURE OF AUTHORIZED GOVERNMENT REPRESENTATIVE

I certify this account is correct and proper for payment.

DATE — SIGNATURE AND TITLE OF CERTIFYING OFFICER

27. SHIP. NO. [ ] PARTIAL [ ] FINAL

28. D.O. VOUCHER NO.

30. INITIALS

31. PAYMENT [ ] COMPLETE [ ] PARTIAL [ ] FINAL

32. PAID BY

33. AMOUNT VERIFIED CORRECT FOR

34. CHECK NUMBER

35. BILL OF LADING NO.

36. RECEIVED AT	38. RECEIVED BY	39. DATE RECEIVED	40. TOTAL CONTAINERS	41. S/R ACCOUNT NUMBER	42. S/R VOUCHER NO.

DD FORM 1155 82 SEP

PREVIOUS EDITION WILL BE USED UNTIL EXHAUSTED.

2

ATTACHMENT NO. 1

GEB REQUISITION NO. 86-60 DACW33-85-D-0011

DELIVERY ORDER NO. 0012

INSPECTION AND EXPLORATION INSTRUCTIONS

PROJECT: Investigation of toe area of Franklin Falls Dam

SITE: Franklin Falls Dam, Franklin, NH

PURPOSE: Examine soils at the upstream toe of dam in the vicinity of a depression on berm area. Conduct dye test and attempt to determine seepage paths.

1. SCOPE OF INVESTIGATION

a. General. Excavate, backfill and compact (with bucket of backhoe) one test pit at specified location (shown on Attachments 2 and 3). Location of pit shall be determined in the field by tape measure by the inspector. Log soil and boulder strata in test pit walls. Fill test pit with water and dye. Conduct a systematic monitoring program of the upstream and downstream toes and inlet and outlet channel areas to check for exit of dyed water.

b. Test Pit. A backhoe with operator will be furnished by the Government. The backhoe shall be used to excavate a test pit up to a depth of 12 feet. Test pit shall be logged (on NED Form 119) by a geologist; all four faces and bottom of pit shall be photographed. Excavated materials shall be placed in three separate piles from each 4 feet depth of excavation for later backfilling in the inverse order of excavation. Side slopes should be sloped to safe angle to avoid cave in. Any tendency for caving and the degree of excavation effort shall be noted on the logs. The test pit will be located on the exploration plan (over an existing depression that measures 9'x 13'x 3'deep) with a minimum of 3 physical ties. Jar and bag samples shall be taken of each major soil strata and the sample depths will be noted on the logs. A cobble and boulder count shall be performed.

Test pit shall be backfilled and compacted as follows:
Backfill material shall be placed in pit with backhoe in uniform loose 24 inch layers, then compacted by pressing, with the bucket of the backhoe until surface of layer is firm and compact.

c. Dye Test. Test pit shall be filled with water to within approximately two feet of the surface (if possible) and maintained at this level during the normal 8-hour working day. The pit will be filled for four consecutive days. Florescent dye (red) shall be added to the water in the test pit in sufficient quantities to keep the water brightly colored. The Government will furnish a 4-inch pump with approximately 500 feet of 4-inch hose. The contractor shall also furnish florescent red dye.

The inspector geologist shall make hourly checks of the upstream and downstream toe areas to observe the exist of dyed water. An inspection route (see attachment 2) will be set up in the field and the inspector will maintain a daily log. Any exit of dyed water will be marked on the plan and promptly reported to Geotechnical Engineering Branch.

2. SITE CONDITIONS

The site is the Corps of Engineers Franklin Falls Dam at Franklin, NH. The test pit will be excavated on the upstream slope as shown on Attachment 2. Inspection for exit dyed water shall be along the upstream and downstream toes of the dam.

Upon completion of the work, the site shall be returned to its original condition and the site will be approved by the dam Project Manager.

3. RIGHTS OF ENTRY

The inspector is responsible for coordinating all work efforts with the Project Manager at the Damsite, Mr. Odias LaRoche, tel. (603)-934-2116).

4. COORDINATION

Mr. Paul L'Heureux, Corps of Engineers (617)-647-8669 shall be contacted five days prior to the start of work and every day during working hours by the inspector to report how work is progressing.

5. EXPLORATION

The exploration shall be designated TP 86-1.

6. GOVERNMENT REVIEW

The Government will review the draft geotechnical report submittal as well as the completed report. Subsequent to such review, the Contractor shall accomplish any corrections which may be directed as the result of the Government review.

7. COMPLETION SCHEDULE

Services under this delivery order shall start within seven calendar days after receipt of the delivery order. The duration of the field work is estimated to be five work days. The geotechnical report shall be submitted in draft format for review (by the Government) no later than seven calendar days after the completion of the field work. Government review will take approximately ten calendar days from receipt of the draft report. The final geotechnical report shall be submitted no later than seven calendar days after the receipt of the draft report and shall incorporate all corrective actions noted by the Government on the draft report.

8. QUALITY CONTROL

You will be held responsible for the quality of the maps submitted and for all damages caused the Government as result of your negligence in the performance of any services furnished under the contract.

Although submissions required by your contract are technically reviewed by the Government, it is emphasized that your work must be prosecuted using proper internal controls and review procedures.

The letter of transmittal for each submission which you make shall include a certification that the submission has been subjected to your own review and coordination procedures to ensure (a) completeness for each discipline commensurate with the level of effort required for that submission; (b) elimination of conflicts, errors, and omissions; and (c) the overall professional and technical accuracy of the submission. Documents which are significantly deficient in any of these areas will be returned to you for correction and/or upgrading prior to our completing our review. Contract submission dates will not be extended if a resubmission of draft material is required for this reason.

b. Project Site

The project is at the site of a flood control dam, containing the water of the Pemigewasset River in Franklin, New Hampshire. The investigation covered an area of subsidence measuring 9'x13'x3' deep on the upstream 25 acre terrace of said dam. The location of the test pit is shown on the test pit excavation drawing in Section 8.

c. Purpose

The purpose of this excavation was to recover soil samples for classification, check for a phreatic surface (if less than 12 feet below grade) and to introduce dye to aid in studying the movement of subsurface water. The information gained by these methods is used to develop an understanding of the causes of the depression area, and what possible remedial action may be necessary.

d. Scope of Work

The scope of work under this Delivery Order primarily consisted of excavation of a test pit (TP-86-1) on the upstream terrace of the Franklin Falls Dam. Excavation was accomplished with equipment and personnel provided by the Army Corps of Engineers, New England Division, as agreed to in Delivery Order No. 0012 (see Section 3a). All related inspection and investigation was supervised by a Geotechnical Engineer and conducted by a Geologist provided by Atlantic Testing Laboratories, Limited.

In addition, a dye tracing test was conducted by said Geologist. The area surrounding the test pit was then monitored for a period of two days to check for any significant discreet subsurface flow.

SECTION 4

QUALITY CONTROL

a. General Certification Statement

I hereby certify that the above-mentioned records, equipment and procedures were used to perform the subsurface exploration described herein. I also certify that the work was performed in a professional manner and meets the requirements set forth in the Delivery Order. This report has been subject to my review and is both complete and technically accurate.

CERTIFIED, July 15, 1986

Spencer F. Thew, P.E./L.S.

b. Records Taken

A Geologist was on-site from Tuesday, July 8, 1986 to Thursday, July 10, 1986 to oversee excavation of the test pit and log daily activities. In addition, a dye test was performed by said Geologist over the same period of time. Soils classifications, boulder counts, and other related information was noted on the test pit field logs (NED119) provided by the Corps of Engineers.

Information pertaining to the dye test was recorded in the Summary of Activities and have been included in Section 5. These logs also include a summary of daily activities, followed by a summary of telephone conversations. In addition, a Chain of Custody Log and Safety Meeting Report have been provided and are located in Sections 6 and 7, respectively.

Pictures of the test pit excavation were taken by a Corps of Engineers Geologist.

c. Equipment Used

A listing of pertinent equipment provided by Atlantic Testing Laboratories, Limited is as follows:

- Ribbon for delineating test pit
- 100 foot survey chain
- Hand Level
- Sample jars
- Fluorescent dye
- Pertinent log forms not provided by the Corps of Engineers

Equipment provided by the Corps of Engineers is listed as follows:

- Backhoe with jaw bucket
- Dump truck
- Centrifugal pump (2") with 500 feet of 1-1/2" fire hose
- Shovel
- Log forms as required

d. Procedures

1) Test Pit

Two representatives of Atlantic Testing Laboratories, Limited were on site for the excavation of the test pit on July 8, 1986. The on-site construction plans were revieved prior to excavation. Said pit was then excavated using a backhoe with a jaw bucket provided and operated by Army Corps personnel. Soil samples were taken and classified on site by a Geologist using the Burmiester and Unified Soils Classification systems, in accordance with ASTM D-2488 and their depths below grade logged on form NED119 (provided by the Army Corps). These classifications systems are based on visual and manual observation. Aboulder count was made, and all unusual voids or soils conditions were noted. In addition, the location of the test pit was found in relation to recoverable points using a 100 foot tape measure.

2) Dye Test

A subsurface flow tracking test was performed by a Geologist using red fluorescent dye as per request of the Army Corps. Approximately 250 gallons of water were used to pre-soak the test pit area in order to keep dye absorption losses to a minimum. Following this presoaking, 0.25 kg of dye, mixed with 20 gallons of water were injected into a void space and followed with about 2000 more gallons of water. The water was added, using a centrifugal pump, at approximately 30 gpm. All previously identified possible resurgences (dye exits) were then monitored at frequent intervals for the remainder of the test.

e. Observations

During the excavation of the test pit, a large number of boulders were found which eventually terminated further investigation at a depth of about nine (9) feet. Between these boulders were noted many large void spaces, some of which were partially filled with fluvial (water borne) deposits. As the only likely source of the material in these deposits is the overlying fill, it seems most reasonable to assume that the depression is the result of settlement caused by filling of the underlying void spaces. This is probably accelerated by high water levels such as those that existed previous to the first sighting of the depression. The fill placed above the boulders, known as "Dumped Fill", received no compaction when placed, other than "movement of the hauling units over the area" (see Specifications for Construction of Franklin Falls Dam, Corps of Engineers, U.S. Army, 1939, section 7-03, paragraph (e)). Such non-compaction would tend to accentuate settlement which would have taken place in any event.

Although the extent of the voids are unknown, it is worth noting that well over 2000 gallons of water was pumped into the test pit in one hour, none of which remained within the confines of the pit for a measureable period of time. Dye injected into these voids was not found to be exiting anywhere near the dam during the duration of the study. Although no definite conclusions can be drawn based on these negative results, it is most probable that the dye and water infiltrated through the boulders and compacted previous fill until its downward motion was arrested by the underlying impervious blanket. Any subsequent lateral motion would be much slower, and dye absorption by clay within the selected previous fill and impervious blanket would probably preclude any future sightings of exiting dye.

SECTION 5

SUMMARY OF ACTIVITIES

AND

CONVERSATION LOGS

TABLE I

SUMMARY OF ACTIVITIES

DATE	Activity
Monday, July 7, 1986	- Mobilize Geologist and Geotechnical Engineer
Tuesday, July 8, 1986	- Time on site: 7:00 A.M. to 4:00 P.M. - Mobilize Geologist and Geotechnical Engineer to site, arrive 7:30 A.M. - Research into design and specifications of dam - Excavate depression area test pit 10:00 to 12:00 - Introduce 230 gallons water to test pit - Inject dye (0.25 kg.) mixed with 20 gallons water into void space. Continue pumping water; total water introduced to test pit approximately 2340 gallons. - Two flow tests show average pumping rate is about 23 gpm. - No dye observed for the remainder of day.
Wednesday, July 9, 1986	Time on site: 7:00 A.M. to 4:30 P.M., 8:00 P.M. to 8:30 P.M. - Engineer demobilized from site: 5:00 A.M. to 7:00 A.M. - Continue observation for dye throughout the day - Test pit backfilled by O. LaRoche, with John Perenteau assisting and Jerry Fairley observing. - Dye check made from 8:00 to 8:30.
Thursday, July 10, 1986	Time on site: 6:30 A.M. to 8:15 A.M. - Further observation for dye. None detected. - Geologist demobilized from site at 8:15 A.M.

TABLE II

CONVERSATION LOGS

Date	Conversation
Tuesday, July 8, 1986	- Discuss dam construction procedures with O. LaRoche.
Wednesday, July 9, 1986	-Paul L'Heureux of Army Corps contacted by telephone about the results of the test pit. He indicated that he was satisfied with the results, and indicated that dye observation should continue until the next morning.
Thursday, July 10, 1986	- Paul L'Heureux contacted by telephone about final results of dye test.

SECTION 6

CHAIN OF CUSTODY LOG

ATLANTIC TESTING LABORATORIES, Limited

CHAIN OF CUSTODY LOG

PROJECT: [illegible] -D- [illegible]

D.0 012

ITEMS:

Tubes	None
Bottles	None
Jar Samples	3 (three) - also note - one [illegible]
Core Boxes	None
Sampling Logs	None

Date & Time Received	Date & Time Transferred	Comments	Custodian
	As sampled	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

SECTION 7

SAFETY REPORT

WEEKLY SAFETY MEETING

NEDSO

Date held 7/08/86

THRU: Area Engineer, New England Area

Time 12:00

TO: Safety Office, NED

1. Weekly safety meeting was held this date for the following personnel:

Contract No. DACW33-85-D-0011 Contractor Atlantic Testing Laboratories, Ltd.

Conducted By J. Fairley All personnel present (Contr) 2
(Sub) _____
(Govt) _____

Subjects discussed (Note, delete, or add):
EM 385-1-1, Section: _____

Accident Prevention Plan - Note of emergency phone #'s.; hospital, ambulance, etc.

Individual Protective Equipment - hard hats, gloves, boots, etc.

Prevention of Falls - note steep or dangerous area:

Back Injury, Safe Lifting Techniques - lift w/ backhoe or ropes in & out of test pit.

Fire Prevention -

Sanitation, First Aid, Waste Disposal - As required

Tripping Hazards - trash, hose, nails in lumber - fire hose, shovel

Staging, Ladders, Concrete Forms, Safety Nets -

Hand Tools, Portable Power Tools, Woodworking Machinery -

Equipment Inspection & Maintenance (Zero Defects) - backhoe

Hoisting Equipment -

Ropes, Hooks, Chains and Slings - hoist rope for bucket

Electrical Grounding, Temporary Wiring, GFCI -

Lockouts for safe clearance procedures - electrical, pressure, moving parts -

Welding, Cutting -

Excavations - Test pit

Loose Rock and Steep Slopes - test pit area

Explosives -

Water Safety -

Toxic materials - hazards, MSDS, respiratory, ventilation -

Other -

Prepared by J. Fairley Title Geologist

2. Forwarded.

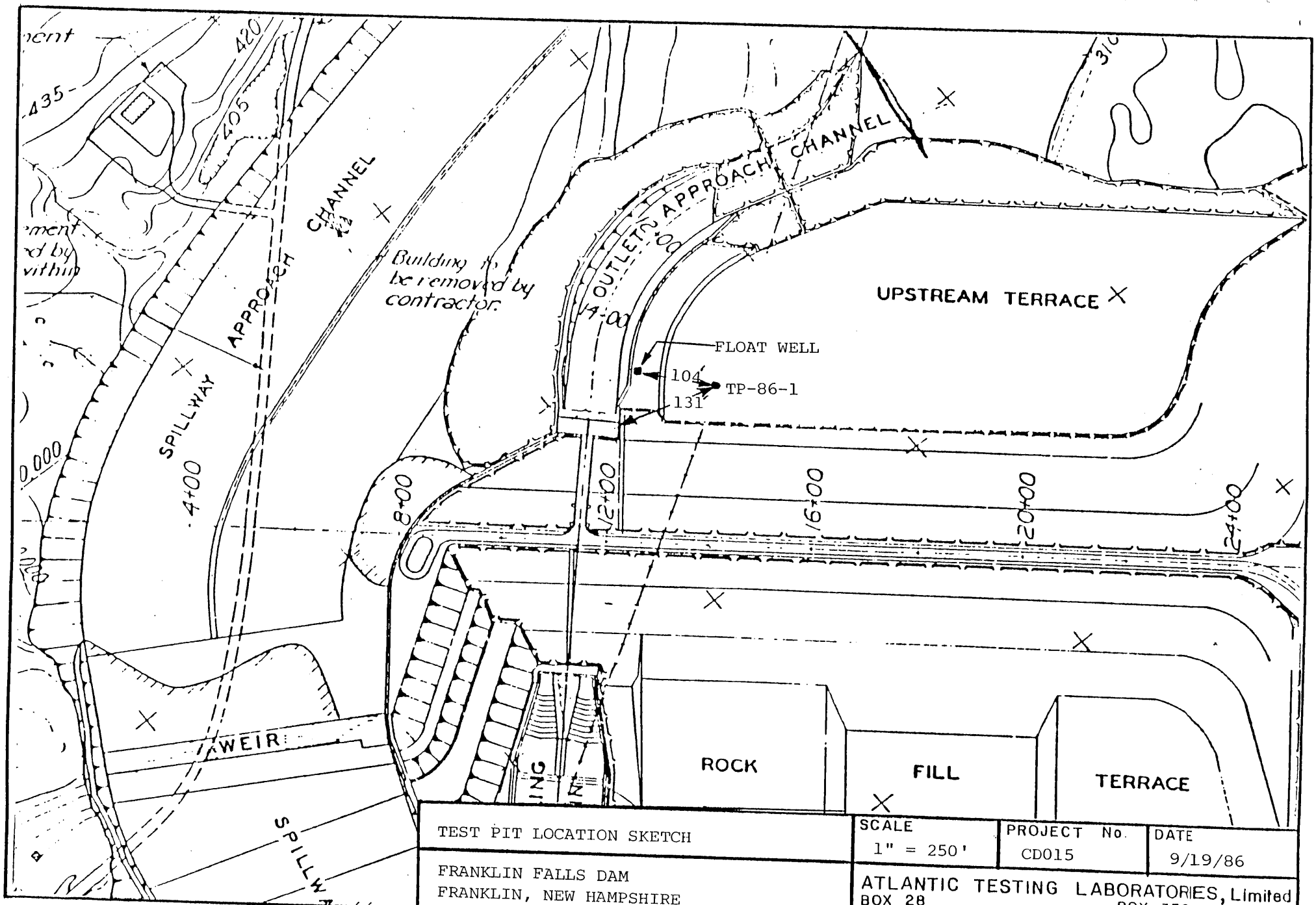
Signature _____
Resident Engineer

CF:

NED APD FL 251

SECTION 8

FIELD INSPECTOR'S LOGS



TEST PIT LOCATION SKETCH

FRANKLIN FALLS DAM
FRANKLIN, NEW HAMPSHIRE

SCALE	PROJECT No.	DATE
1" = 250'	CD015	9/19/86

ATLANTIC TESTING LABORATORIES, Limited
BOX 28
CANTON, NY. 13617
BOX 356
CICERO, NY. 13039

CORPS OF ENGINEERS
NEW ENGLAND DIVISION
FOUNDATIONS & MATERIAL BRANCH

FIELD LOG OF FOUNDATION AND BORROW INVESTIGATION

SITE FRANKLIN FALLS DAM TYPE EXPLORATION TEST PIT DATE 7/08/[illegible]
EXPLORATION NO. TP-86-1 CO-ORD. STA 14+00* @ 320'Lt * GROUND ELEV. 342'±
PURPOSE OF EXPLORATION SURFACE DEPRESSION

*ESTIMATED (SEE SKETCH

DEPTH 1" = 2'	SAMPLE'S No.	SAMPLE'S Depth	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION	REMARKS AND FIELD TEST DATA
2	JAR S-1	2.0'		BROWN, MOIST, SAND, TR. GRAVEL; TR. SILT TR COBBLES, TR ORGANICS (ROOT HAIRS)	
4				GRAY, MOIST, GRAVELLY SAND, TR SILT, COBBLES & BOULDERS BECOMING MORE NUMEROUS WITH DEPTH	
6	S-2	5.5			NOTE: COLLECTED BAG SAMPLE
8	S-3	7.5			
9				INCREASE IN SOIL MOISTURE @ 8.5'	REFUSAL IN NESTED BOULDERS WITH MANY LARGE VOIDS
				EXPLORATION TERMINATED	@ 9'

DIMENSIONS OF TEST PIT 16'X 10'X 9' DEEP VOL. REPRESENTED 1440 CU. FT.

COBBLES & BOULDERS:
4"-6" Diam. No. NOT Vol. ESTIMATED Cu. Ft
6"-18" Diam. No. 54 Vol. 27 Cu. Ft. ESTIMATED
Over 18" No. 30 Vol. 240 Cu. Ft. ESTIMATED

WATER TABLE DEPTH NOT APPARENT

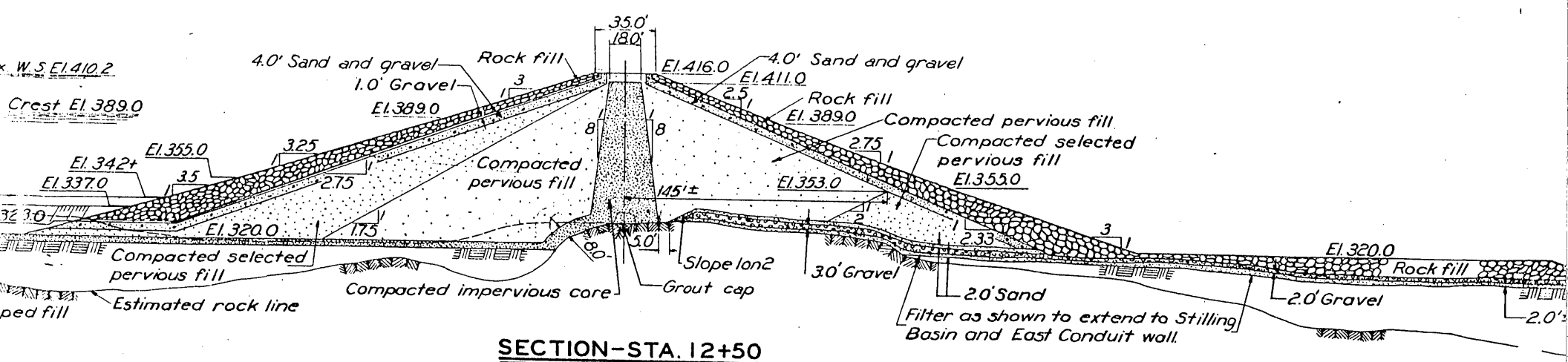
Remarks: BOULDER COUNT MADE DURING BACKFILLING OPERATIONS

Submitted by PAUL FISHER

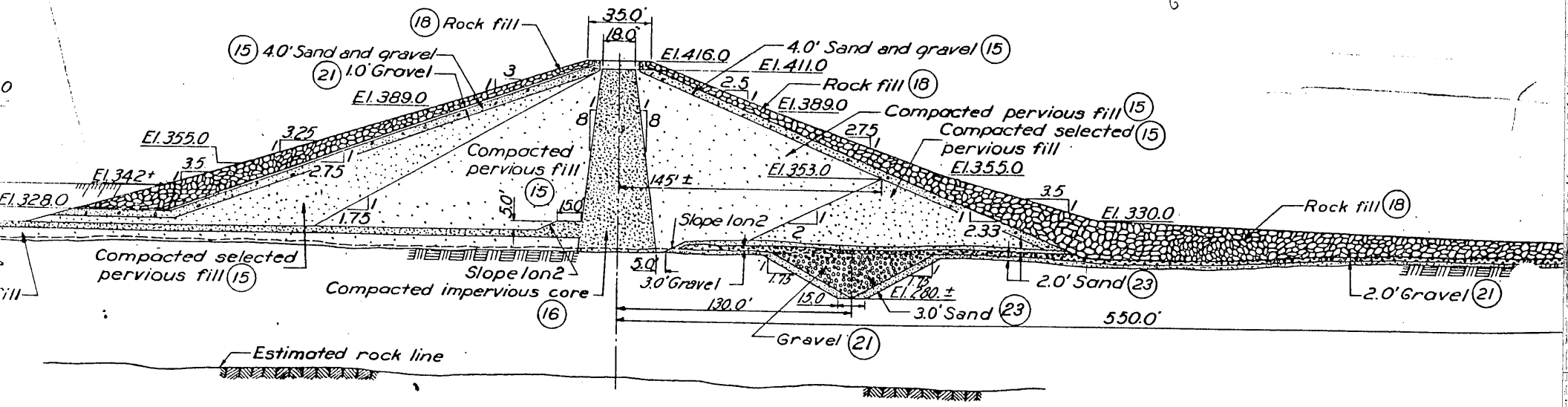
NED FORM DEC 63 119 REPLACES EDITION OF AUG 57 WHICH MAY BE USED UNTIL EXHAUSTED

SECTION 9

OTHER RECORDS TAKEN

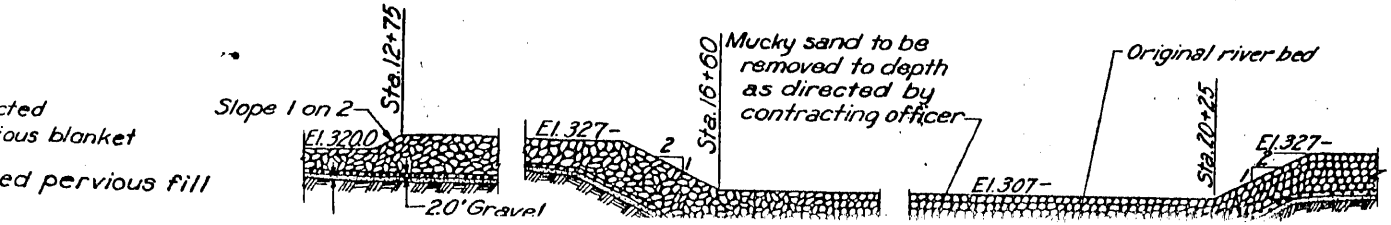


SECTION–STA. 12+50



SECTION–STA. 15+50

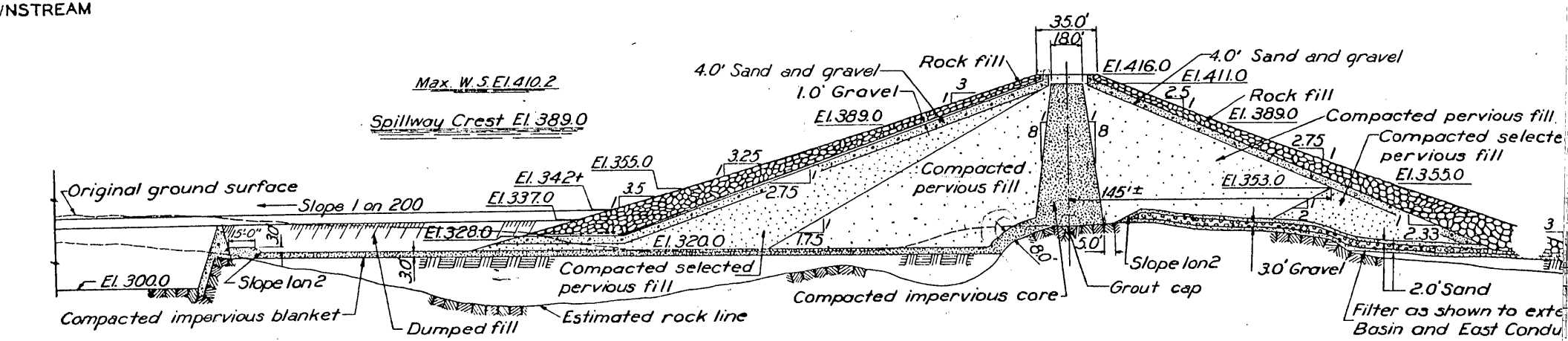
General Notes:
Figures in circles indicate ite
which payment will be made.



MERRIMACK VALLEY F
FRANKLIN FALL
PEMIGEWASSET
EMBANKMENT DET

SECTION–STA. 10+00

TYPICAL FOR EMBANKMENT FROM SPILLWAY WALL TO EAST CONDUIT



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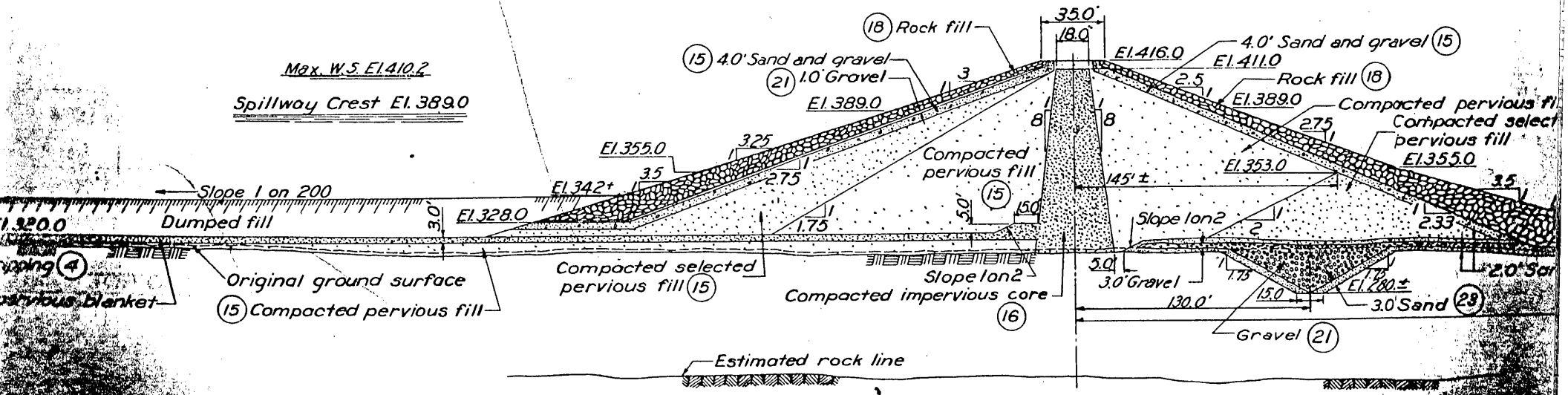

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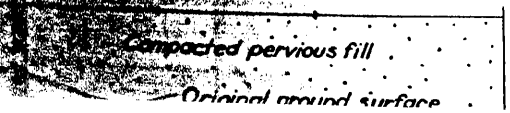
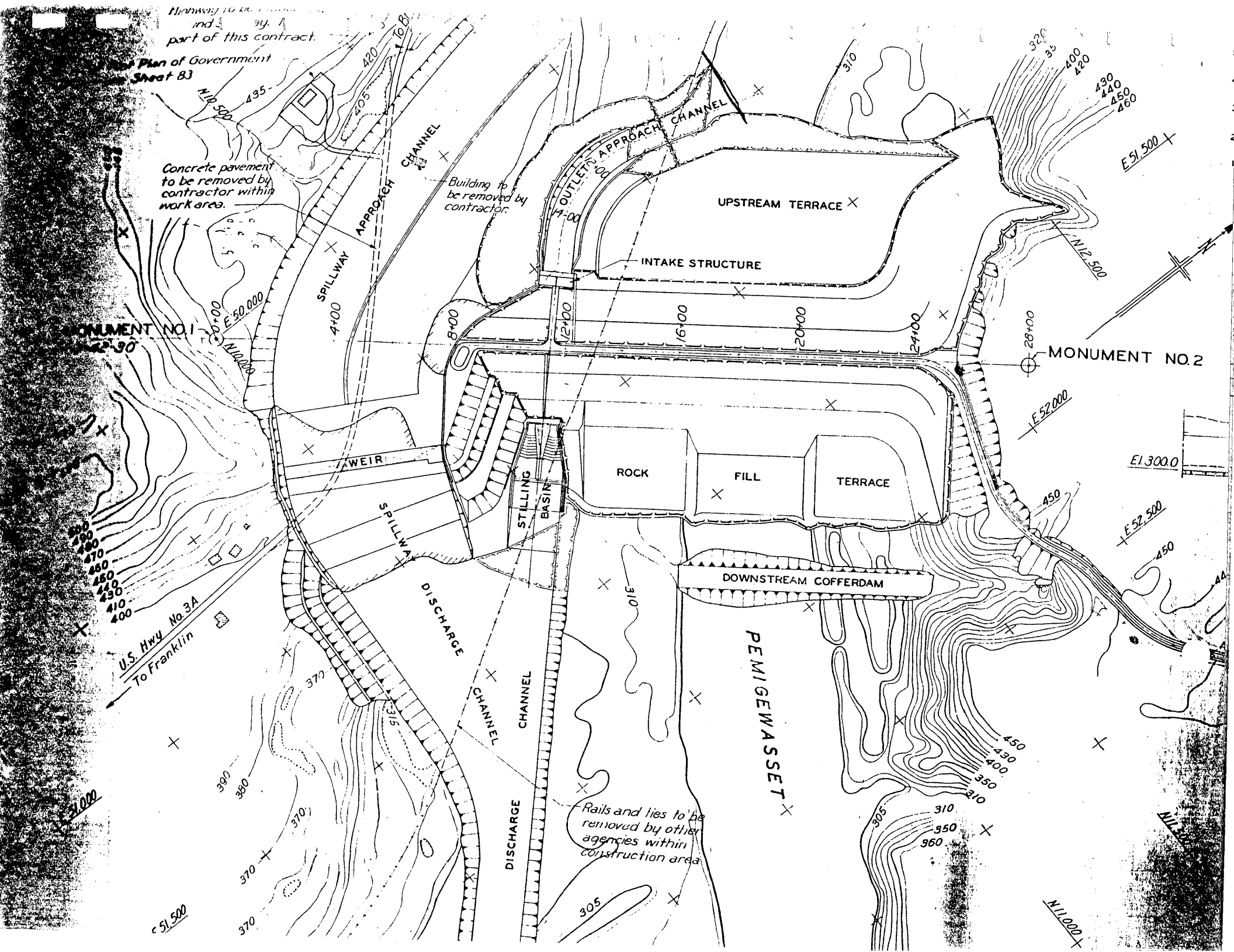
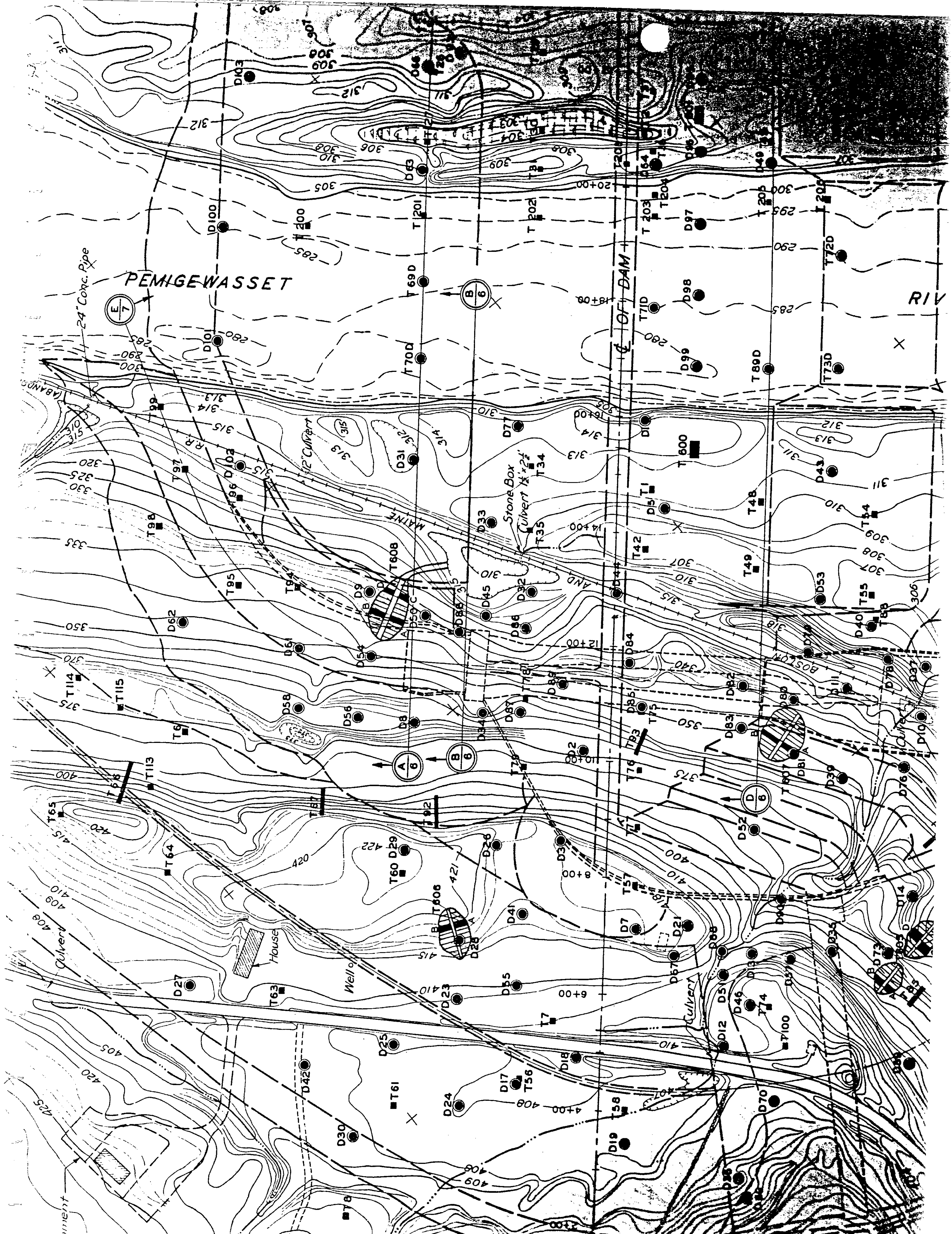



part of this contract.
Plan of Government
Sheet 83
Concrete pavement to be removed by contractor within work area.
Building to be removed by contractor.
APPROACH CHANNEL
SPILLWAY
OUTLET APPROACH CHANNEL
UPSTREAM TERRACE
INTAKE STRUCTURE
MONUMENT NO. 1
MONUMENT NO. 2
WEIR
STILLING BASIN
ROCK
FILL
TERRACE
DOWNSTREAM COFFERDAM
DISCHARGE CHANNEL
PEMIGEWASSET
U.S. Hwy No. 3A
To Franklin
Rails and ties to be removed by other agencies within construction area
E 50,000
E 51,500
E 52,000
E 52,500
N 10,500
N 12,500
N 11,000
El 300.0


PEMIGEWASSET
RIV
24" Conc. Pipe
℄ OF DAM
12" Culvert
Stone Box Culvert 1½'x2½'
R.R.
MAINE
AND
BOSTON
House
Well
Culvert

Sandy soil.

Fine to Medium Sand.

Very Silty Fine Sand with bands of Sandy Silt.

Banded, Silty Fine Sand and Silt. Scattered Pebbles.

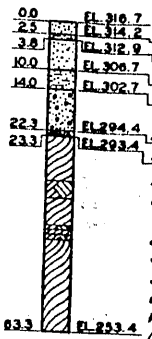
Silty Fine Sand with minor bands of Silt. Cobble at elev. 283.3

Compact, Sandy Silt. Occasional Gravelly Silt bands.

Variable Gravelly Sands with little or no Silt. Considerable Coarse Gravel and Cobbles.

Micaceous Gneiss with coarse Granite below elev. 233.3. Solid, with numerous stained partings and occasional very small fractures. Core recovery 93%

D-32



Sandy soil.

Very Silty Fine Sand.

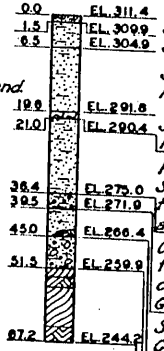
Wash boring

Compact Very Silty Fine Sand. Very Gravelly Fine to Coarse Sand.

Boulder or loose rock.

Micaceous Gneiss with Granite veins at elev. 284.2-280.7, 275.7-274.7 and 273.7-272.7. Solid, with numerous stained partings and occasional irregular very small fractures. Core recovery 97%

D-33



Sandy loam with 0.7' muck. Silty Fine Sand.

Slightly Silty Very Fine to Medium Sand.

Soft Mucky Silt with Rotten Wood.

Fine Sand and Coarse Silt. Slightly Silty Fine to Very Coarse Sand at elev. 278.4-276.9.

Compact, Silty Very Fine to Medium Sand with considerable admixture of Gravel and Cobbles.

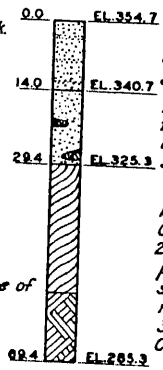
Slightly Silty Fine to Coarse Sand. Boulder at elev. 267.4-266.4.

Compact, Very Silty Fine Sand with considerable admixture of Gravel and Cobbles.

Micaceous Gneiss with Granite veins at elev. 257.4-255.9 and below 247.4. Solid, with occasional stained partings.

Core recovery 86%

D-34

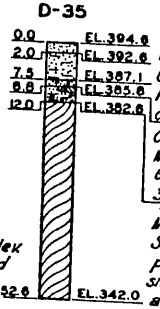


Washboring. Banded Fine Sand and Fine to Coarse Sand.

Washboring. Compact, Fine to Coarse Sand with Boulders at elev. 334.5-333.7 and 327.7-326.7.

Micaceous Gneiss with Coarse Granite below elev. 299.2. Solid, with stained partings and very small fractures very numerous above elev. 314.7 but rare below Core recovery 95%

D-35



Very Fine Sandy Soil.

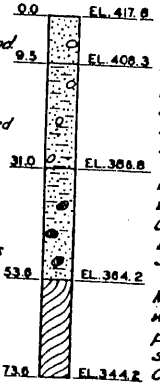
Coarse Silty Very Fine Sand.

Fine to Coarse Sand with occasional Pebbles.

Compact, Silty Very Fine to Medium Sand with Scattered Gravel. Boulder at elev. 385.8-384.6.

Micaceous Gneiss. Solid, with stained partings and very small fractures numerous above elev. 350.6 but rare below. Sand filled fracture at elev. 360.1-359.9. Core recovery 96%

D-36



Washboring. Fine to Medium Sand. Cobble at elev. 412.3.

Washboring. Compact, Silty Fine to Medium Sand. Cobbles at elev. 403.3, 396.8, and 387.8

Washboring. Compact, variably Silty Fine to Coarse Sand. Small Boulders at elev. 380.3, 377.8, 375.8, 374.3, and

Micaceous Gneiss. Solid with occasional stained partings and rare very small fractures. Core recovery 96%

Notes:
Overburden dry-sampled unless otherwise no
Bedrock diamond core-drilled.
Symbols conventional. Refer to text for all data.
Location of exploration shown on Sheets 4 and 5.
Elevations conform to U.S.G.S. datum.
Refer to Sheet 8 for definition of terms.

MERRIMACK VALLEY FLOOD
FRANKLIN FALLS DA
PEMIGEWASSET RIVE
RECORD OF FOUNDATI
EXPLORATION—NO.

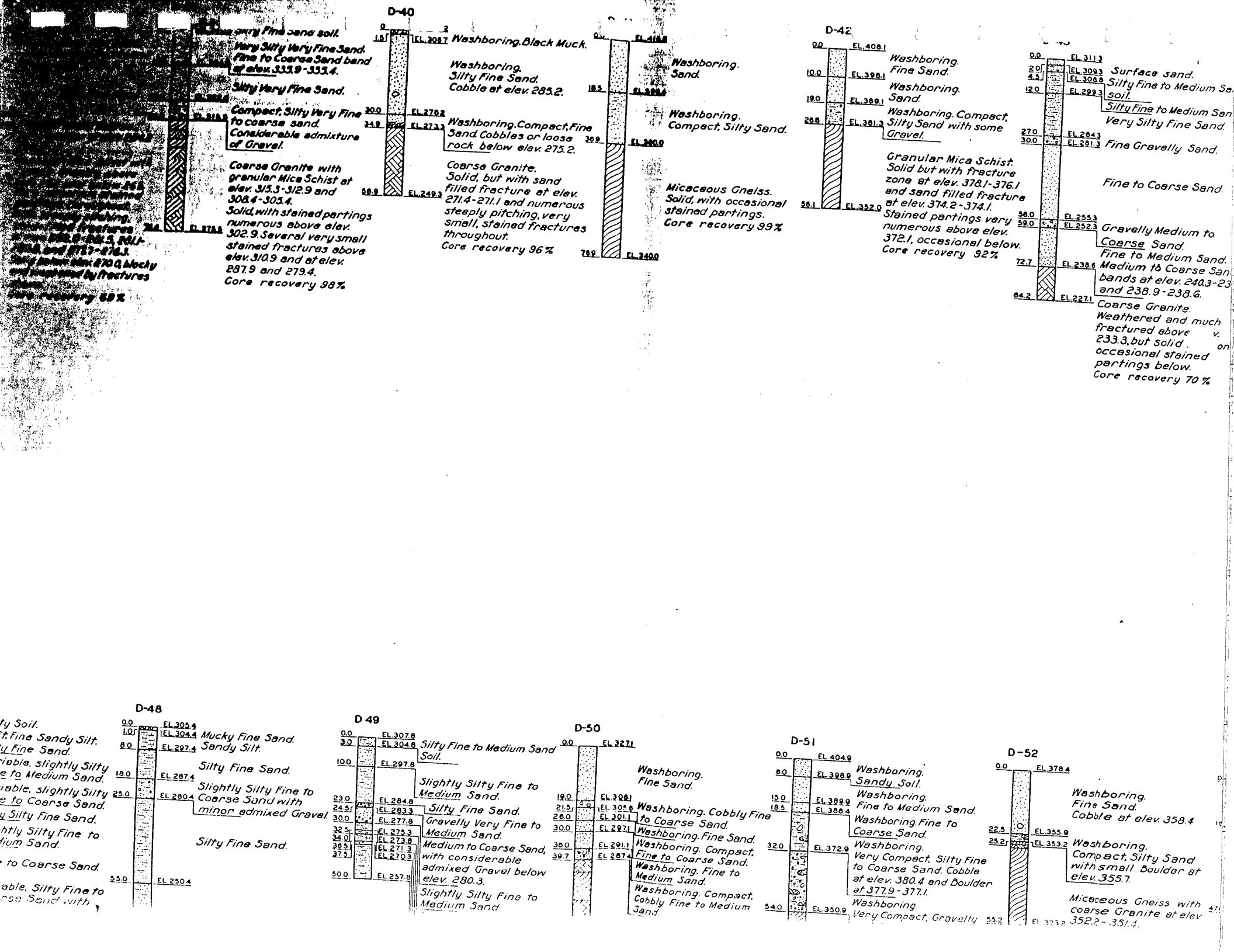
IN 86 SHEETS

SHEET NO. 9

U. S. ENGINEER OFFICE, BOSTON, MASS.,

SUBMITTED:

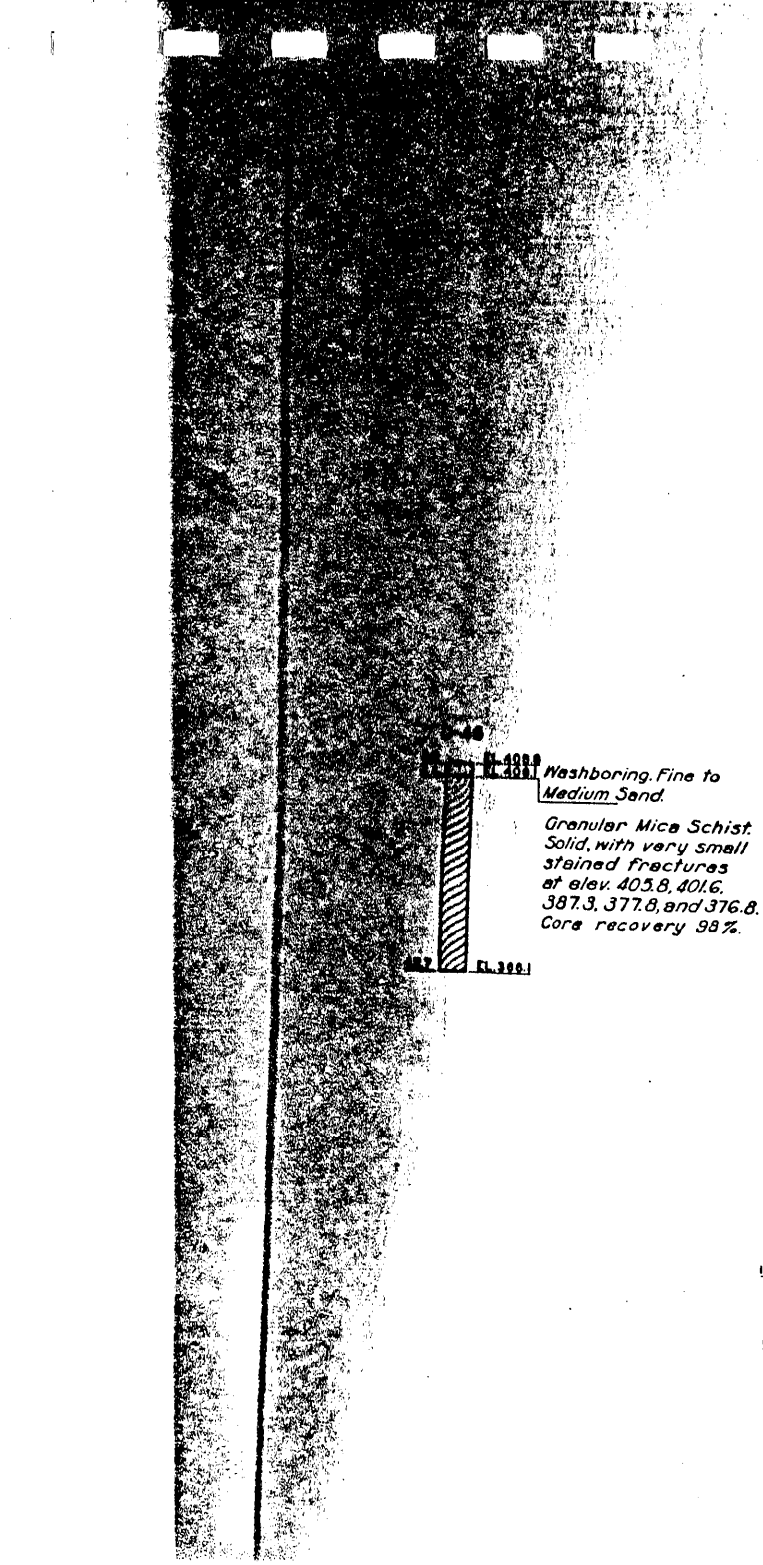
APPROVED:


Very Fine Sand soil.
Very Silty Very Fine Sand. Fine to Coarse Sand band at elev. 333.9 - 333.4.
Silty Very Fine Sand.
Compact, Silty Very Fine to coarse sand. Considerable admixture of Gravel.
Coarse Granite with granular Mica Schist at elev. 315.3 - 312.9 and 308.4 - 305.4. Solid, with stained partings numerous above elev. 302.9. Several very small stained fractures above elev. 310.9 and at elev. 287.9 and 279.4. Core recovery 98%.
D-40
EL. 308.7 Washboring. Black Muck.
Washboring. Silty Fine Sand. Cobble at elev. 285.2.
EL. 279.2
EL. 273.3
Washboring. Compact, Fine Sand. Cobbles or loose rock below elev. 275.2.
EL. 249.3
Coarse Granite. Solid, but with sand filled fracture at elev. 271.4 - 271.1 and numerous steeply pitching, very small, stained fractures throughout. Core recovery 96%
EL. 418.8
Washboring. Sand.
EL. 398.4
Washboring. Compact, Silty Sand.
EL. 390.0
Micaceous Gneiss. Solid, with occasional stained partings. Core recovery 99%
EL. 340.0
D-42
EL. 408.1
Washboring. Fine Sand.
EL. 398.1
Washboring. Sand.
EL. 389.1
Washboring. Compact, Silty Sand with some Gravel.
EL. 381.3
Granular Mica Schist. Solid but with fracture zone at elev. 378.1 - 376.1 and sand filled fracture at elev. 374.2 - 374.1. Stained partings very numerous above elev. 372.1, occasional below. Core recovery 92%
EL. 352.0
EL. 311.3
EL. 309.3
EL. 308.8
Surface sand.
Silty Fine to Medium Sa... soil.
EL. 299.3
Silty Fine to Medium San...
Very Silty Fine Sand.
EL. 284.3
EL. 281.3
Fine Gravelly Sand.
Fine to Coarse Sand.
EL. 255.3
EL. 252.3
Gravelly Medium to Coarse Sand.
Fine to Medium Sand.
Medium to Coarse San... bands at elev. 240.3 - 23... and 238.9 - 238.6.
EL. 238.6
EL. 227.1
Coarse Granite. Weathered and much fractured above ... v. 233.3, but solid ... on occasional stained partings below. Core recovery 70%
D-48
EL. 305.4
EL. 304.4
Mucky Fine Sand.
Sandy Silt.
EL. 297.4
Silty Fine Sand.
EL. 287.4
Slightly Silty Fine to Coarse Sand with minor admixed Gravel.
EL. 280.4
Silty Fine Sand.
EL. 250.4
D 49
EL. 307.8
EL. 304.8
Silty Fine to Medium Sand Soil.
EL. 297.8
Slightly Silty Fine to Medium Sand.
EL. 284.8
EL. 283.3
Silty Fine Sand.
Gravelly Very Fine to Medium Sand.
EL. 277.8
EL. 275.3
EL. 273.8
EL. 271.3
EL. 270.3
Medium to Coarse Sand, with considerable admixed Gravel below elev. 280.3.
EL. 257.8
Slightly Silty Fine to Medium Sand.
D-50
EL. 327.1
Washboring. Fine Sand.
EL. 308.1
EL. 306.6
Washboring. Cobbly Fine to Coarse Sand.
EL. 301.1
Washboring. Fine Sand.
EL. 297.1
Washboring. Compact, Fine to Coarse Sand.
EL. 291.1
EL. 287.4
Washboring. Fine to Medium Sand.
Washboring. Compact, Cobbly Fine to Medium Sand.
D-51
EL. 404.9
Washboring. Sandy Soil.
EL. 398.9
Washboring. Fine to Medium Sand.
EL. 388.9
EL. 386.4
Washboring. Fine to Coarse Sand.
EL. 372.9
Washboring. Very Compact, Silty Fine to Coarse Sand. Cobble at elev. 380.4 and Boulder at 377.9 - 377.1.
EL. 350.9
Washboring. Very Compact, Gravelly
D-52
EL. 378.4
Washboring. Fine Sand. Cobble at elev. 358.4
EL. 355.9
EL. 353.2
Washboring. Compact, Silty Sand with small Boulder at elev. 355.7.
Micaceous Gneiss with coarse Granite at elev. 352.2 - 351.4.

above.

rec. 69%

Core recovery 98%



D-46

EL. 408.8
EL. 401.6
EL. 388.1

Washboring. Fine to Medium Sand.

Granular Mica Schist. Solid, with very small stained fractures at elev. 405.8, 401.6, 387.3, 377.8, and 376.8. Core recovery 98%.

D-47

0.0	EL. 302.5
2.0	EL. 300.5 — Silty Soil.
5.5	EL. 297.0 — Soft, Fine Sandy Silt.
10.0	EL. 292.5 — Silty Fine Sand.
19.0	EL. 283.5 — Variable, slightly Silty Fine to Medium Sand.
23.0	EL. 277.5 — Variable, slightly Silty Fine to Coarse Sand.
29.0	EL. 273.5 — Very Silty Fine Sand.
40.0	EL. 262.5 — Slightly Silty Fine to Medium Sand.
	Fine to Coarse Sand.
56.0	EL. 246.5 — Variable, Silty Fine to Coarse Sand with Some Fine to Medium Gravel and occasional Pebbles.
73.0	EL. 229.5 — Variable, slightly Silty Fine to Medium Sand. Gravelly Sand bands at elev. 214.5-213.5 and 204.5-202.5.
102.7	EL. 199.8 — Granular Micaceous Schist with coarse Granite below elev. 193.5. Solid.
117.7	EL. 184.8

Core recovery 93%

D-48

0.0	EL. 305.4
1.0	EL. 304.4 — Mucky Fine Sand.
8.0	EL. 297.4 — Sandy Silt.
	Silty Fine Sand.
18.0	EL. 287.4
25.0	EL. 280.4 — Slightly Silty Fine to Coarse Sand with minor admixed Gravel
	Silty Fine Sand.
55.0	EL. 250.4
	Silty Fine to Medium Sand.
72.0	EL. 233.4
	Silty Fine Sand.
82.0	EL. 223.4
	Slightly Silty Fine to Medium Sand.
100.0	EL. 205.4

Bedrock not reached.

D 49

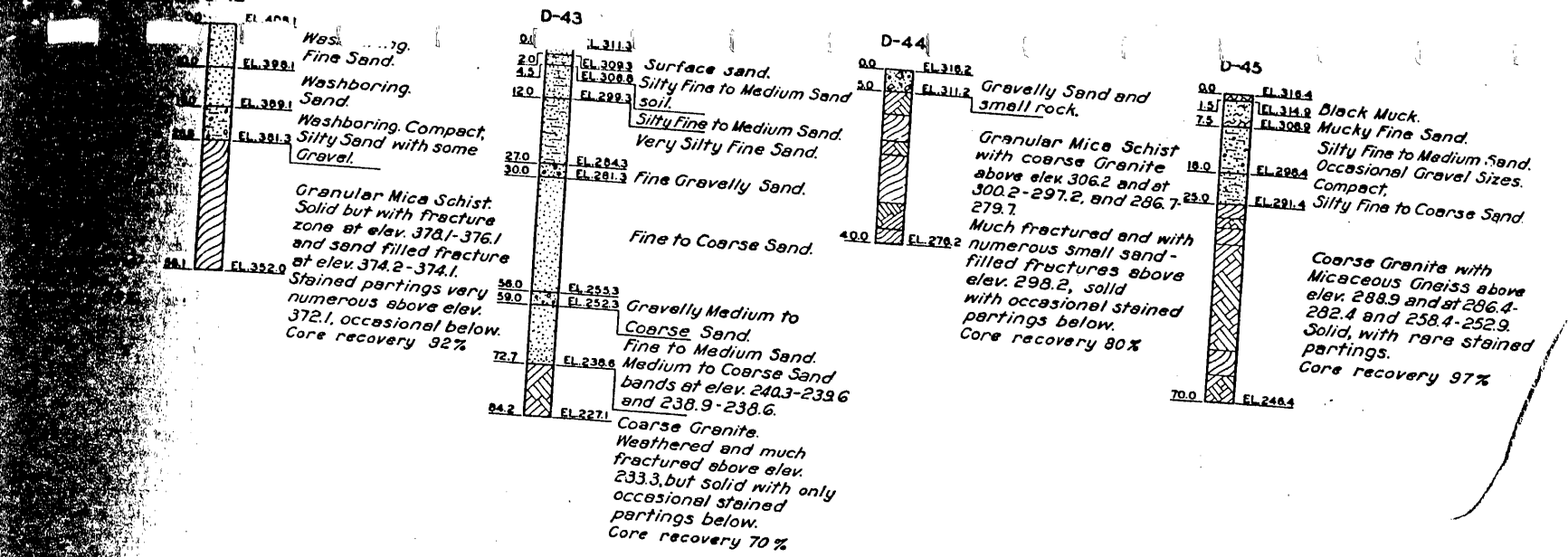
0.0	EL. 307.8
3.0	EL. 304.8 — Silty Fine to Medium Sand Soil.
10.0	EL. 297.8
	Slightly Silty Fine to Medium Sand.
23.0	EL. 284.8
24.5	EL. 283.3 — Silty Fine Sand.
30.0	EL. 277.8 — Gravelly Very Fine to Medium Sand.
32.5	EL. 275.3
34.0	EL. 273.8 — Medium to Coarse Sand, with considerable admixed Gravel below elev. 280.3.
36.5	EL. 271.3
37.5	EL. 270.3
	Slightly Silty Fine to Medium Sand.
50.0	EL. 257.8
	Slightly Silty Fine to Coarse Sand.
	Silty Fine Sand.
	Slightly Silty Fine to Very Coarse Sand.
	Variable, Silty Fine Sand and Silty Fine to Medium Sand.

Bedrock not reached.

D-50

0.0	EL. 327.1
	Washb... Fine S...
19.0	EL. 308.1
21.5	EL. 305.6 — Washb... to Co...
26.0	EL. 301.1
30.0	EL. 297.1 — Washb...
	Washb... Fine t...
36.0	EL. 291.1
39.7	EL. 287.4 — Washb... Mediu...
	Washb... Cobbly Sand.
69.7	EL. 257.4

...ac... ...elev. 2... ...below... Solid. ...staine... ...occasi... ...fract... Core ...


D-43
0.0
EL. 311.3
2.0
EL. 309.3
4.5
EL. 306.8
12.0
EL. 299.3
27.0
EL. 284.3
30.0
EL. 281.3
56.0
EL. 255.3
59.0
EL. 252.3
72.7
EL. 238.6
84.2
EL. 227.1
Surface sand.
Silty Fine to Medium Sand soil.
Silty Fine to Medium Sand.
Very Silty Fine Sand.
Fine Gravelly Sand.
Fine to Coarse Sand.
Gravelly Medium to Coarse Sand.
Fine to Medium Sand.
Medium to Coarse Sand bands at elev. 240.3-239.6 and 238.9-238.6.
Coarse Granite.
Weathered and much fractured above elev. 233.3, but solid with only occasional stained partings below.
Core recovery 70%
D-44
0.0
EL. 316.2
3.0
EL. 313.2
40.0
EL. 276.2
Gravelly Sand and small rock.
Granular Mica Schist with coarse Granite above elev. 306.2 and at 300.2-297.2, and 286.7-279.7.
Much fractured and with numerous small sand-filled fractures above elev. 298.2, solid with occasional stained partings below.
Core recovery 80%
D-45
0.0
EL. 316.4
1.5
EL. 314.9
7.5
EL. 308.9
18.0
EL. 298.4
25.0
EL. 291.4
70.0
EL. 246.4
Black Muck.
Mucky Fine Sand.
Silty Fine to Medium Sand. Occasional Gravel Sizes. Compact,
Silty Fine to Coarse Sand.
Coarse Granite with Micaceous Gneiss above elev. 288.9 and at 286.4-282.4 and 258.4-252.9. Solid, with rare stained partings.
Core recovery 97%

D-51
0.0
EL. 404.9
0.0
EL. 398.9
15.0
EL. 389.9
18.5
EL. 386.4
32.0
EL. 372.9
54.0
EL. 350.9
60.0
EL. 344.9
Washboring.
Sandy Soil.
Washboring.
Fine to Medium Sand.
Washboring. Fine to Coarse Sand.
Washboring.
Very Compact, Silty Fine to Coarse Sand. Cobble at elev. 380.4 and Boulder at 377.9-377.1.
Washboring.
Very Compact, Gravelly and Cobbly Silty Sand. Boulders at elev. 355.9-
D-52
0.0
EL. 378.4
22.5
EL. 355.9
25.2
EL. 353.2
55.2
EL. 323.2
Washboring.
Fine Sand.
Cobble at elev. 358.4.
Washboring.
Compact, Silty Sand with small Boulder at elev. 355.7.
Micaceous Gneiss with coarse Granite at elev. 352.2-351.4.
Solid, with very numerous
D-53
0.0
EL. 307.2
16.1
EL. 291.1
47.0
EL. 260.2
Washboring.
Fine Sand.
Granular Mica Schist. Solid but badly fractured; with shatter zones at elev. 291.1-290.2 and 278.2-276.2, open or sand-filled fractures at elev. 282.5-282.1, 278.8-278.6, 274.4-274.3 and 269.7-
D-54
0.0
EL. 344.1
18.0
EL. 326.1
22.0
EL. 322.1
52.0
EL. 292.1
Washboring.
Compact, Sand with scattered Pebbles.
Gravelly below elev. 327.6.
Washboring. Compact, Silty Sand with considerable admixture of Gravel and Cobbles.
Granular Mica Schist. Solid, with numerous stained partings and very small fractures.

MERRIMACK VALLEY FLOOD CONTROL

SPECIFICATIONS

FOR

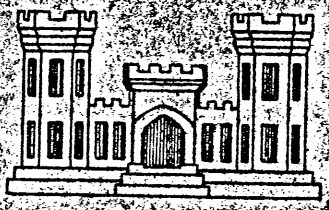
CONSTRUCTION

OF

FRANKLIN FALLS DAM

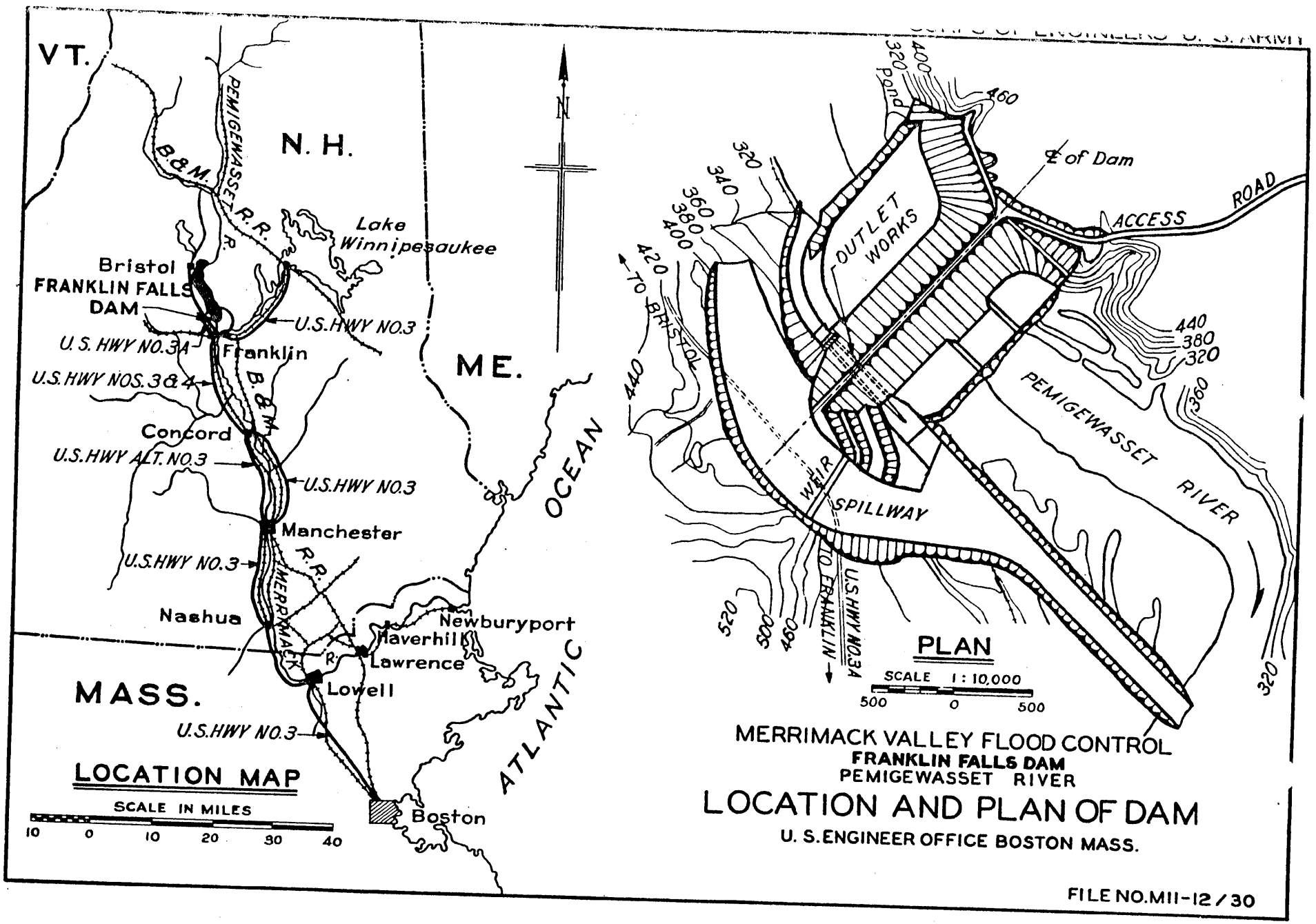
PEMIGEWASSET RIVER

1939



CORPS OF ENGINEERS, U. S. ARMY

U. S. ENGINEER OFFICE BOSTON, MASS.



MERRIMACK VALLEY FLOOD CONTROL

FRANKLIN FALLS DAM

PEMIGEWASSET RIVER

LOCATION AND PLAN OF DAM

U. S. ENGINEER OFFICE BOSTON MASS.

FILE NO. M11-12/30

SECTION VII. DAM EMBANKMENT, BACKFILL, AND PROTECTION OF EARTH SURFACES

7-01. DEFINITION AND CLASSIFICATION.- The term "dam embankment" as used in these specifications includes all the pervious and impervious fill sections of the dam and abutments, the upstream and downstream terraces, the rock fill, backing and filters in the dam including the upstream and downstream terraces and in the abutments, and the compacted backfill around the outlet structures. The work covered by this section is classified as follows:

(a) Earth Fill (see paragraph 7-03)
  (1) Preparation of foundation
  (2) Compacted impervious core
  (3) Compacted impervious blankets
  (4) Compacted pervious fill
  (5) Compacted selected pervious fill
  (6) Dumped fill

(b) Compaction of Earth Fill (see paragraph 7-04)

(c) Structure Backfill - Compacted and Uncompacted (see paragraph 7-05).

(d) Rock Fill (see paragraph 7-06)

(e) Filters (see paragraph 7-07)

(f) Sand and Gravel Backing (see paragraph 7-08)

(g) Gravel Backing (see paragraph 7-09)

(h) Drains (see paragraph 7-10)

(i) Protection Stone (see paragraph 7-11)

(j) Placing Top Soil and Seeding (see paragraph 7-12)

(k) Piezometers, Settlement Gages and Wells (see paragraph 7-13)

(l) Concrete Stairs (see paragraph 7-14)

7-02. GENERAL PROVISIONS.- (a) Lines and Grades. The embankment shall be constructed to the lines and grades shown on the drawings or otherwise required by the contracting officer, increased by such heights and widths as may be determined necessary by the contracting officer to allow for subsequent shrinkage or settlement. The portions of the dam embankment placed on the river terraces prior to diversion of the river shall have slopes normal to the river not steeper than 1 on 3. The toes of these slopes shall not be located closer to the river than Station 15+80 on the west bank and Station 20+50 on the east bank.

(b) Materials. Materials for the various sections of the dam embankment shall conform to the respective requirements specified in the following paragraphs of this section. The order and location of structure excavation and of borrow area excavation and the deposit in the embankment of these materials shall be subject to the direction of the contracting officer. No brush, roots, sod and perishable or objectionable materials, as determined by the contracting officer, shall be placed in the embankment. Any objectionable material placed in the embankment shall be removed by the contractor as directed by the contracting officer, without cost to the Government. The suitability of each part of the foundation for placing embankment materials thereon and of all materials for use in the embankment will be determined by the contracting officer.

No materials shall be placed in the embankment when either the materials or the foundation on which they are to be placed are frozen.

(c) Conduct of the Work. The contractor shall at all times maintain the embankment in a manner satisfactory to the contracting officer until the final completion and acceptance of all work under the contract. The contractor may be required to suspend work at any time when, in the opinion of the contracting officer, satisfactory work cannot be done on account of rain, floods, cold weather, or other unsatisfactory conditions. Any approved embankment material which is lost or rendered unsuitable after being placed in the embankment and before the completion and final acceptance of the work, due to causes that, in the opinion of the contracting officer, are avoidable, or under the control of the contractor, shall be replaced by the contractor in a manner satisfactory to the contracting officer and without cost to the Government (see also paragraph 4-06). The contracting officer may require the contractor to remove without cost to the Government any material placed by the contractor outside of specified slope lines, except for material required to be placed for shrinkage or settlement.

(d) Measurement and Payment. The volume of embankment to be paid for will be measured between the original ground surface after stripping, corrected for settlement as measured by settlement gages hereinafter specified, and the lines, slopes, and grades of the finished embankment as shown on the drawings or as established by the contracting officer. Measurement will be made subsequent to compaction wherever compaction is prescribed. The payment for embankment will be as specified in the following paragraphs of this section regardless of the source of the placed material and will be in addition to any payment specified for excavation in Section V, transportation of the material, stockpiling, and rehandling necessary or required.

7-03. EARTH FILL.- (a) Preparation of Foundation. The foundation shall be excavated or stripped to the depth and extent indicated on the drawings or as otherwise required. The drainage trenches in the foundation of the dam embankment in the river bed and in the river terraces as shown on the drawings shall be excavated and filled as specified in paragraph 7-10. The test pits, test trenches, stump holes and other excavated areas, depressions or cavities (see paragraph 3-02) within the limits of the dam embankment shall be filled with pervious or impervious fill as directed by the contracting officer. The fill shall be placed in layers, moistened, and rolled in accordance with paragraphs 7-03(g), (h) and 7-04, whenever, in the opinion of the contracting officer, it is possible to do so. Materials which cannot be compacted by roller equipment, on account of clearances, shall be spread in 4-inch layers and compacted with power tampers of a type approved by the contracting officer which shall give the degree of compaction required for similar materials in the dam embankment. As the fill is brought up, the side slopes of the cut or hole shall be scarified, if, in the opinion of the contracting officer, it is required, in order to provide a bond between the fill and the original ground material. The sides of stump holes shall be broken down, if necessary, so as to flatten out the slopes, and the hole then filled with approved material and properly rolled or tamped in place. Immediately prior to placing

materials in the dam embankment, the entire foundation, except where it consists of rock, and except the foundation of the upstream cofferdam, shall be scarified to a depth of 4 inches and shall be leveled and rolled with the same number of passes as hereinafter specified for pervious embankment. It is the intention that the immediate foundation underlying the fill shall be as compact as the pervious fill and shall be well bonded to the overlying fill or filter. The foundation upon which earth fill or filter is placed, except that placed under water in the upstream cofferdam, shall be in a suitably dry condition, as determined by the contracting officer (see Section IV).

(b) Impervious Fill. Material for the compacted impervious core and compacted impervious blankets of the dam embankment shown on the drawings or as modified by the contracting officer, shall be secured from Borrow Area A as specified in paragraph 5-07. Each load of material to be placed in the compacted impervious core or in the compacted impervious blankets shall be the equivalent, as nearly as practicable, of a mixture of materials obtained from an approximately uniform strip or cutting from the full height of a lift in excavation. The combined excavation and embankment placing operations shall be such that the materials when compacted in the core and in the blanket will be blended sufficiently to secure the best practicable degree of compaction, impermeability and stability.

(c) Pervious Fill. Material for the compacted pervious fill sections of the dam embankment shown on the drawings or as modified by the contracting officer shall be secured from any required common excavation (see paragraph 5-08); provided that any material from required common excavation which is suitable for selected pervious fill as specified in paragraph 7-03(d) shall be selected for such use. The combined excavation and embankment placing operations shall be such that the materials when compacted in the pervious fill sections will be blended sufficiently to secure the best practicable degree of compaction and stability.

(d) Selected Pervious Fill. To secure materials suitable for use in the compacted selected pervious fill sections of the dam embankment shown on the drawings, or as modified by the contracting officer, the contracting officer will prescribe the excavation in such manner (see paragraphs 5-07 and 5-08) as to secure a well graded mixture of sand and gravel of which at least 10 percent by weight shall be retained on the 1/4-inch standard mesh sieve and, of the material passing the 1/4-inch standard mesh sieve, not more than 5 percent by weight shall pass the No. 200 standard mesh sieve. Preference shall be given to the use in the selected pervious fill sections of any material from required common excavation which conforms to these requirements (see paragraph 7-03(c)). If any material from required common excavation shall be found to meet the specified requirements for selected pervious fill, thereby reducing the amounts of material to be secured from Borrow Areas B or C, or both, no change therefor will be made in any of the respective contract unit prices.

(e) Dumped Fill. Materials from required common excavation not approved by the contracting officer for use as pervious fill, selected pervious fill, or backfill, or which are in excess of the requirements therefor, shall be placed in the uncompacted section of the upstream terrace of the dam. Any materials in excess of the requirements for the dam embankment, including the abutments and the upstream terrace, shall be disposed of as specified

in paragraph 5-03. The fill shall be dumped and spread in horizontal layers not to exceed 3 feet in thickness or as directed. Compaction other than that obtained by the controlled movement of the hauling units over the area will not be required.

(f) Objectionable Materials. In addition to the objectionable material specified in paragraph 7-02(b), no stones which would be retained on a 6-inch screen will be permitted in the compacted impervious core, or the compacted pervious and compacted selected pervious fill sections of the dam embankment, and no stones which would be retained on a 3-inch screen will be permitted in the compacted impervious blanket. Should stones of such sizes be found in the otherwise approved earth fill embankment materials, they shall be removed by the contractor either at the site of the excavation or after transporting to the embankment, but prior to compacting the materials in the dam embankment.

(g) Placement. The distribution and gradation of materials throughout the compacted earth fill sections of the dam shall be such that the dam embankment will be free from lenses, pockets, streaks, or layers of material differing materially in texture or gradation from the surrounding material. The dumping of the material from the different parts of the required common excavation and from Borrow Areas B and C shall be at locations on the embankment as directed by the contracting officer, and for this purpose the contracting officer may direct the points in the embankment where individual loads shall be deposited, to the end that the more pervious material shall be placed in the outer portions of each section. In particular, the most pervious material classified as selected pervious fill shall be placed within the outer 6 feet, measured horizontally, of each selected pervious section. After dumping, the materials shall be spread by bulldozers or other approved methods in approximately horizontal layers over the prepared foundation or the rolled fill. The impervious material shall be harrowed where necessary, by passing over the material in such layers with a disc type harrow a sufficient number of times to break and cut up lumps for more effective rolling. The thickness, before compaction, of each layer of material shall be not greater than 6 inches for impervious material nor more than 12 inches for pervious and selected pervious materials. The layers shall extend at an approximately uniform elevation over the entire width of the cross-section of the dam and for the entire length of the section under construction. The top surface of the embankment during construction shall be kept crowned, with grades not to exceed 4 percent, so that the fill will drain freely toward the slopes, and shall be maintained at all times in such manner that no water pockets will be formed under any weather conditions. If, in the opinion of the contracting officer, the rolled surface of any layer is too smooth to bond properly with the succeeding layer, it shall be roughened or loosened by scarifying to the satisfaction of the contracting officer before the succeeding layer is placed thereon. Ruts in the surface of any layer shall be filled in a manner satisfactory to the contracting officer, before compacting.

(h) Moisture Control. The impervious, the pervious and the selected pervious materials in each layer, while being compacted by rolling, shall contain the amount of moisture required for optimum compaction, as determined by the contracting officer, and the moisture

content shall be unifc throughout the layer. The apj cation of water to the impervious material, if required for this purpose (see paragraph 5-07(b)), shall be done at the borrow area in so far as practicable, as determined by the contracting officer, and shall be supplemented as required by sprinkling in place on the embankment. The amount of water applied shall be accurately metered so that the minimum amount of applied water shall bring the water content of the material to the optimum for compaction. The optimum moisture content for the impervious material is approximately 10 to 15 percent by weight and for the pervious and selected pervious materials is approximately 20 to 25 percent by weight, but the contracting officer reserves the right to vary the moisture content as may be required. The optimum moisture content for the pervious and selected pervious materials approximates the moisture content of these materials when saturated. The contractor shall maintain adequate facilities to provide the amount of water required. If deemed necessary by the contracting officer, the compacted layer shall be sprinkled previous to the laying of an uncompacted layer.

7-04. COMPACTION OF EARTH FILL.- (a) Equipment. Equipment consisting of a double drum sheepsfoot tamper roller, or a disc tamping roller, pulled by a crawler type tractor weighing not less than 20,000 pounds and which is weighted or equipped with a bulldozer, or both, to increase its totalweight to not less than 29,000 pounds, shall be used for compacting the earth fill in the embankment. The design and operation of the compacting equipment shall be subject to the approval of the contracting officer. The speed of the compacting equipment shall be not more than 3-1/4 miles per hour. The rollers shall conform to the following requirements:

(1) Sheepsfoot roller. Each drum of the double tamper roller shall be approximately 4 feet in width and shall have tamping feet uniformly staggered over its cylindrical surface and be provided with cleaners. Each tamping foot shall project approximately 7 inches from the roller's cylindrical surface and shall have a face area of not less than 5 nor more than 7 square inches. The spacing shall be such as to provide not less than 1-1/2 tamping feet for each square foot of cylindrical surface. The sheepsfoot roller shall be weighted so that the total weight of the roller and ballast in pounds divided by the total area of the maximum number of tamping feet in 1 row generally parallel to the axis of the roller shall be not less than 200 pounds per square inch. Tamping feet shall be added or removed as directed by the contracting officer.

(2) Disc roller. The disc roller shall have approximately 12 discs with face widths not less than 1-1/2 inches nor more than 2-1/2 inches. The discs shall be not less than 40 inches in diameter and shall be spaced approximately 6 inches center to center. Each disc shall be free to revolve independently of the other discs. The roller shall be weighted so that the mean intensity of pressure on the segmental face area subtended by a chord having a middle ordinate of 1 inch shall be not less than 60 pounds per square inch.

(b) Compacting Impervious Fill. When each layer of the impervious fill has reached the moisture content required for optimum compaction as specified in paragraph 7-03(h), the layers

shall be compacted by passing the tractor and either roller specified in paragraph 7-04(a) over the layer 6 complete passes of the tractor treads. One pass of the tractor treads as used herein is defined as one complete coverage by the tractor treads over the entire surface of the layer. If the moisture content is greater or less than that required for optimum compaction, the rolling shall be delayed until the proper moisture content, as determined by the contracting officer, has been reached.

(c) Compacting Pervious and Selected Pervious Fill. When each layer of pervious or selected pervious earth fill has attained the moisture content required for optimum compaction as specified in paragraph 7-03(h), it shall be compacted by passing the tractor and either roller specified in paragraph 7-04(a) over the layer 6 complete passes of the tractor treads as defined in paragraph 7-04(b). If the moisture content is greater or less than that required for optimum compaction, the rolling shall be delayed until the proper moisture content, as determined by the contracting officer, has been reached. The contractor shall thoroughly roll the embankment at the junctions of the pervious, selected pervious, sand and gravel backing, and impervious sections, extending the rolling specified herein onto the adjacent sections of the embankment to secure bonding of the sections as directed by the contracting officer.

(d) Tests for Compaction. Samples of all embankment materials for testing, both before and after placement and compaction, will be taken by the contracting officer at frequent intervals, and from these tests, corrections, adjustments and modifications of methods, materials, moisture content, or requirement for additional compaction will be made in order to secure the desired compaction of the materials in the embankment. In taking these samples the contractor shall supply labor required to assist the inspector, as directed by the contracting officer, in accordance with the requirements of paragraph 1-18.

(e) Payment. Payment for all work in connection with the preparation of the foundation for the dam embankment and the spreading, mixing, scarifying, harrowing, sprinkling, compacting, removing objectionable stones or other material, and all other incidental work required to construct the compacted earth fill sections of the embankment in accordance with the specifications, except as specified in paragraph 7-05(d), will be made at the contract unit price, Item No. 15, for the pervious and selected pervious materials, and Item No. 16 for the impervious material, as applicable.

7-05. FILL OVER AND AGAINST CONCRETE STRUCTURES.- (a) General. Backfill or other load shall not be placed against or on top of concrete surfaces before the expiration of the minimum number of days after placing the concrete indicated below, except when specifically authorized by the contracting officer:

Walls and vertical faces	7 days
Conduits	14 days

Subsequent to 14 days, but prior to 28 days after placing concrete in the conduits, no equipment except that needed for placing and compacting fill on top of the conduits will be permitted to pass over the conduits, and during this period fill placed to a depth of 4 feet

immediately adjacent the top of the conduits shall placed as specified in paragraph 7-05(c). The depth of backfill over the concrete conduits in the dam embankment shall be sufficient, in the opinion of the contracting officer, to permit passage of equipment other than as specified above without inducing harmful stresses or vibrations in the concrete before passage of such equipment will be permitted.

(b) Structure Backfill, Uncompacted. The term "structure backfill, uncompacted" as used in these specifications applies to backfilling excavations for concrete structures which are outside the slope lines of the dam embankment. Materials for uncompacted backfill shall be free from roots, brush, or other objectionable material and shall be obtained from required common excavation. No frozen material shall be placed, nor shall backfill be placed on frozen surfaces. The contractor may be required to use sluicing or jetting in its placement.

(c) Structure Backfill, Compacted. The term "structure backfill, compacted" as used in these specifications applies to backfilling excavations for concrete structures which are in general within the slope lines of the dam embankment and where, in the opinion of the contracting officer, it is impracticable to compact the prescribed earth fill materials by rolling. Materials for compacted backfill shall conform to the requirements of paragraph 7-03 for the respective types of earth fill shown on the drawings or as modified by the contracting officer. The specified materials shall be placed in layers 4 inches in thickness before compaction, and shall be wetted and tamped with power tampers of a type approved by the contracting officer to give compaction equal to that required for adjoining rolled fill embankment materials of the same type.

(d) Measurement and Payment. The measurement for payment for backfill will be made of the actual volume of backfill in place as determined from surveys made before and after placing backfill. Payment for "Structure backfill, uncompacted" will be made at the contract unit price, Item No. 13; for "Structure backfill, compacted" at the contract unit price, Item No. 14.

7-06. ROCK FILL.- (a) General. The upstream and downstream sections and the downstream terrace of the embankment, and the areas on the east abutment as shown on the drawings, shall be constructed of rock fill placed to the lines and grades shown on the drawings or as modified by the contracting officer in accordance with paragraph 7-02. The rock fill shall consist of a free-draining mixture of sound rock from the required excavations or from borrow areas (see paragraph 5-03). The largest rock in the rock fills shall be not more than 1 cubic yard in volume. The different sizes shall be well distributed throughout the rock fill. Not more than 40 percent of the rock fill above Elevation 389.0 M.S.L. on the upstream slope of the dam embankment and above Elevation 389.0 M.S.L. on the east abutment shall be composed of rock smaller than 3 cubic feet and the maximum size shall be 1/4 cubic yard. The inclusion of rock spalls resulting from blasting operations will be permitted provided that the spalls are free from sand or other overburden. Loose rock in excavations shall be thoroughly washed, where necessary, to remove silt, sand and other objectionable overburden before the rock is

placed in the fill. Where rock fill is placed directly against gravel backing, sand and gravel backing, or filters, selected small sizes of rock shall be placed adjacent to the sand, sand and gravel, or gravel so that the dumping and placing of the rock fill will not disturb the filter or backing. Rock fill on the embankment and east abutment shall be placed in approximately horizontal layers not exceeding 3 feet in thickness as the earth fill progresses, and shall be kept at substantially the same level as the earth fill, except that the placement of the rock fill on the embankment section constructed on the west terrace prior to diversion of the river may be delayed until the earth fill of this section has been placed; provided that the manner of placement of the rock fill shall be satisfactory to the contracting officer and provided that it shall be placed before diversion of the river is started. Such hand placing of the finished rock surface will be required as will insure a reasonably smooth and continuous surface to the slope lines shown on the drawings, or as modified by the contracting officer, with a tolerance not exceeding ± 9 inches.

(b) Measurement and Payment. Measurement of rock fill will be made in embankment only between the slope lines and grade lines shown on the drawings or as modified by the contracting officer. Payment will be made at the contract unit price, Item No. 18, which price shall include payment for the selection of materials, washing, placing, and all other work required for the completion of all rock fills in accordance with these specifications. Separate payment will be made for rock excavation as specifically provided in paragraph 5-09(c).

7-07. FILTERS.- The filter on the foundation under the compacted pervious and selected pervious fill downstream sections of the dam embankment, as shown on the drawings or as modified by the contracting officer, shall be 7 feet thick comprising 3 courses: The first or bottom course shall be 2 feet of sand, the second course shall be 3 feet of gravel laid on the first course, and the third course shall be 2 feet of sand laid on the gravel. The filters on the foundation under the downstream rock fill terrace as shown on the drawings, or as modified by the contracting officer, shall be 4 feet thick, comprising 2 courses: 2 feet of sand overlain by 2 feet of gravel. Sand for filters shall be graded as specified in paragraph 8-06 for fine concrete aggregate, except that the addition of fine sand to supply the deficiencies in the percentages of material passing the No. 50 and No. 100 sieves as specified therein for fine aggregate will not be required. Gravel for filters shall be coarse concrete aggregate with maximum size 2 inches as specified in paragraph 8-07 except that size separation as specified in paragraph 8-07(c)(2) will not be permitted. The filters shall be placed and protected in a manner subject to the approval of the contracting officer, so as to insure that they will not be damaged during the construction operations. The courses in the filters under the compacted pervious and selected pervious fill downstream sections of the dam embankment shall be placed separately in horizontal layers 12 inches thick before compaction and shall be compacted by passing the tractor specified in paragraph 7-04(a) over the layer 6 complete passes of the tractor treads as defined in paragraph 7-04(b). The courses in the filters under the downstream rock fill terrace shall be placed separately in horizontal layers 12 inches thick and shall not be compacted. The material in the filters shall be thoroughly

and uniformly moistened sprinkling during placing. M urement for filters will be made between the slope lines shown on the drawings or as modified by the contracting officer. Payment for gravel for filters will be made at the contract unit price, Item No. 21; for sand for filters at the contract unit price, Item No. 23. The contract prices Items 21 and 23 shall include payment for all excavation, screening, stockpiling, hauling, placing and compacting as well as stripping and final grading of the borrow area. No separate payment for excavation of materials to be processed will be made.

7-08. SAND AND GRAVEL BACKING. - A layer of sand and gravel backing of the thickness shown on the drawings shall overlie the earth fill and the stripped surface of the downstream portion of the east abutment where indicated on the drawings or directed by the contracting officer. The material for the sand and gravel backing shall be a well-graded sand and gravel of which not less than 25 percent by weight shall be retained on the 1/4-inch standard mesh sieve, and of the material passing the 1/4-inch standard mesh sieve, not more than 5 percent by weight shall pass the No. 200 standard mesh sieve. The contractor shall select material conforming to these requirements from Borrow Areas B or C in the manner specified in paragraph 5-07. The backing shall be placed in horizontal layers of the same thickness as the pervious earth fill and rolled in a similar manner. The layers shall be kept at substantially the same elevation as the earth fill and shall be thoroughly and uniformly moistened by sprinkling during placing. Measurement for sand and gravel backing will be made between the slope and grade lines shown on the drawings or as modified by the contracting officer. Payment for sand and gravel backing will be made at the contract unit price, Item No. 15. Material for sand and gravel backing will also be paid for as excavation (see paragraph 5-07).

7-09. GRAVEL BACKING. - A layer of gravel backing of the thickness shown on the drawings shall be placed under rock fill where indicated on the drawings or directed by the contracting officer. This backing shall be graded as specified for gravel for filters in paragraph 7-07. Gravel backing (except in the upstream cofferdam as specified in Section IV) shall be placed in horizontal layers which shall not be rolled. The surface of the gravel backing shall be kept not more than 3 feet below the surface of the sand and gravel backing and shall be thoroughly and uniformly moistened by sprinkling during placing. The gravel backing will be measured in place to the slope and grade lines indicated on the drawings or as modified by the contracting officer. Payment for gravel backing will be made at the contract unit price, Item No. 21, which price shall include excavating, processing, stockpiling, hauling and placing, as well as stripping and final grading of the borrow area.

7-10. DRAINS. - (a) Drainage Trenches on Terraces. A drainage trench normal to the river shall be constructed in the right and left terrace sections of the embankment foundation. Excavation and backfilling of the trenches shall be done in the dry, the method of dewatering the trench to be selected by the contractor subject to the approval of the contracting officer. The location, depth, bottom width, side slopes

and limits of the trenches shall be as indicated on the drawings; provided that the bottom elevation of the trench may be modified by the contracting officer to limits 5 feet higher or lower than indicated and provided that the side slopes may be either flatter or steeper than indicated on the drawings as required by the method of construction subject to limitations determined by the contracting officer. A layer of sand 3 feet thick conforming to the requirements of paragraph 7-07 for sand for filters shall be placed against the side of the trench. The balance of the trench shall be filled with gravel graded as specified for gravel for filters in paragraph 7-07. The sand and the gravel fill shall be brought up simultaneously by depositing in approximately 12-inch loose layers and shall be compacted by a tractor conforming to the requirements of paragraph 7-04(a). Each layer of the fill shall be covered by 6 complete passes of the tractor treads as defined in paragraph 7-04(b). Payment for excavation of the trenches on the terraces will be made at the applicable contract unit price, Item No. 5 or No. 6. Payment for sand and for gravel will be made at the contract unit prices, Item No. 23 and Item No. 21, respectively. The measurement for payment for both excavation and backfill will be made to the bottom width and to the slopes indicated on the drawings and to the depth limits directed by the contracting officer.

(b) Drainage Trench in River Bed. A drainage trench in the foundation of the river section of the embankment shall be constructed in the location and to the depth, bottom width, side slopes and limits as indicated on the drawings; provided that the bottom elevation of the trench may be modified by the contracting officer within limits 5 feet higher or lower than indicated and provided that the side slopes will be permitted to assume the natural slopes resulting from the excavation. The excavation may be made in the wet provided that the level of the water table in the vicinity shall be drawn down to Elevation 280 M.S.L. The trench shall be backfilled with sand conforming to the requirements of sand for filters as specified in paragraph 7-07. Payment for excavation of the trench in the river will be made at the contract unit price, Item No. 6. Payment for sand backfill will be made at the contract unit price, Item No. 23. The measurement for payment for both excavation and backfill will be made to the bottom width and to the slopes indicated on the drawings and to the depth limits directed by the contracting officer.

(c) Cobble Gutters. Cobble gutters shall be constructed in the locations shown on the drawings or as directed by the contracting officer. The rock for the gutters shall be sound rock obtained from required rock excavation. The rock shall be hand placed to a minimum depth of 6 inches with broken joints on gravel backing to line and grade to form a paved drain as shown on the drawings. The gravel backing shall be placed with a minimum depth of 6 inches as shown on the drawings and shall conform to the requirements of paragraph 7-09. Payment for cobble gutters will be made at the contract unit price, Item No. 58, which price shall include shaping, furnishing and placing gravel backing, placing the rock, and all other work required. Payment will also be made separately for excavation of rock, as specified in Section V.

(d) Catch Basins. The cobble gutters on the side slope of the west abutment shall be provided with catch basins of the size and at the locations shown on the drawings. The catch basins shall be connected as shown on the drawings with 12-inch vitrified pipe drains. Payment for catch basins will be made at the respective contract unit prices for the materials required.

(e) Pipe Drains. The contractor shall install 12-inch vitrified pipe drains in the locations indicated on the drawings. The pipe shall conform to the requirements of Federal Specification SS-P-361 for "Pipe; Clay, Sewer," and shall be laid to the depths and grades directed by the contracting

officer. Bell holes shall be excavated to insure that each pipe rests firmly upon its bed for its entire length. All stones shall be removed from the bed to a depth of 6 inches and the voids backfilled with suitable material well compacted. The pipe connecting the catch basins shall be caulked with jute or hemp and then carefully and thoroughly filled with Portland cement mortar well rammed in with wooden caulking tool, then overfilled and left with smooth finished surface. The mortar shall be composed of 1 part Portland cement and 1 part sand with enough water added to obtain the proper consistency. The pipe shall not be moved after the joints are caulked. The pipe drain along the west conduit near the stilling basin shall be laid in and backfilled with gravel and shall have 1/2 inch open joints. Payment for vitrified pipe drains will be made at the contract unit price, Item No. 59.

7-11. PROTECTION STONE. - (a) General. Protection stone shall be sound stone selected from the required rock excavation or borrow areas (see paragraph 5-03) and approved by the contracting officer. Payment for the rock excavation, including hauling, stockpiling, rehandling and disposal where necessary, will be made under the respective contract unit prices for rock excavation.

(b) Hand-Placed Riprap. Hand-placed riprap shall be used for slope protection where indicated on the drawings or directed by the contracting officer. The riprap shall be laid on an 8-inch layer of gravel backing as specified in paragraph 7-09. The riprap shall be 18 inches thick measured normal to the slope or surface, unless otherwise directed. The stones in general shall not weigh over 250 pounds each and not more than 10 percent of the whole shall weigh less than 15 pounds each. They shall be of uniform shape so as to furnish an even, reasonably smooth face for the surface of the riprap. The stone shall be hand placed, close together generally with greatest dimension normal to the slope. The stone shall be roughly coursed with courses running horizontally on slopes. Riprap shall be started at the foot of slopes and carried up course after course with the stone breaking joints as far as practicable. The spaces between the larger stones shall be filled with driven spalls so as to form a dense, compact mass. At least one-half of the area of paving shall be composed of stones having a depth equal to the thickness of the paving, and so far as practicable, shall be uniformly distributed so as to cover one-half the slope area at any section where riprap is required. Hand-placed riprap will be measured to the slope and grade lines shown on the drawings or as modified by the contracting officer, and payment will be made at the contract unit price, Item No. 19.